

## Cerebellum (Li): Worksheet/Study Guide

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The following is a worksheet and study guide (some tables are completed) based on the objectives. There is no answer key, as any answers may be found from the lecture notes/outline. Things to focus on: microscopic properties, connections (especially SCP feedback loops), and *functions*. Also see note at end regarding knowing the cerebellar diseases.

### 1. To become familiar with the major architectural features of cerebellum

#### External Architecture

<i>Anatomical Divisions of Cerebellar Cortex</i>		
<b>LOBES</b>	<i>Anterior</i>	
	<i>Posterior</i>	
	<i>Flocculonodular</i>	
<b>LOBULES</b>	10	
<b>FOLIA</b>	Gyri	

<i>Morphology</i>		
<b>HEMISPHERES &amp; TONSILS</b>	2	
<b>VERMIS</b>	<i>Anterior (Superior)</i>	Lobules II-VIIa
	<i>Posterior (Inferior)</i>	Lobules VIIb-X

<i>Cerebellar Peduncles</i>		
<b>Cerebellar Peduncle</b>	<b>Other Name</b>	<b>Connects Cerebellum to</b>
<b>INFERIOR (ICP)</b>	<i>Corpus restiform</i>	Medulla
<b>MIDDLE (MCP)</b>		
<b>SUPERIOR (SCP)</b>		

<i>Surroundings</i>	
<b>BRAINSTEM</b>	Cerebellum connects with brainstem via peduncles
<b>4<sup>th</sup> VENTRICLE</b>	Cerebellum forms roof
	Anterior and posterior vela
	Bilateral foramina of Luschka
<b>SUBARACHNOID SPACE</b>	Cerebellum is surrounded by CSF inside posterior fossa

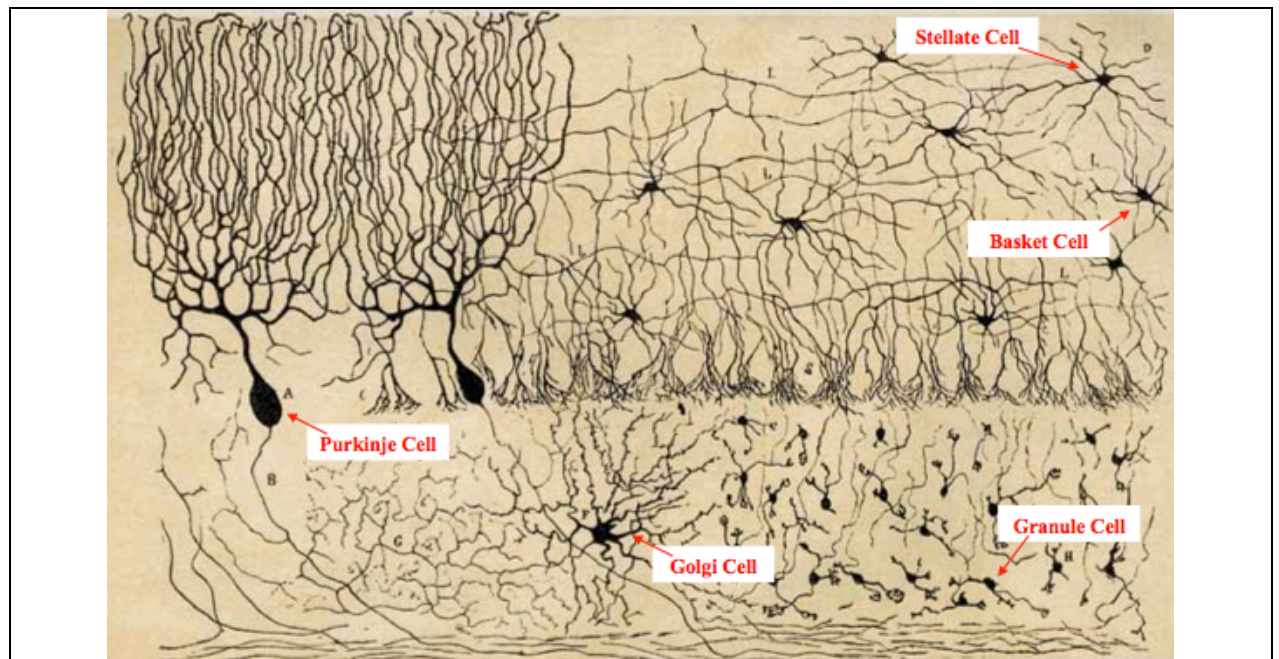
<i>Blood Supply</i>		
Arteries from vertebrobasilar (posterior circulation) arterial system		
<b>Cerebellar Artery</b>	<b>Arises from</b>	<b>Supplies</b>
<b>SCA Superior</b>		
<b>AICA Anterior Inferior</b>		
<b>PICA Posterior Inferior</b>		

## Internal Architecture

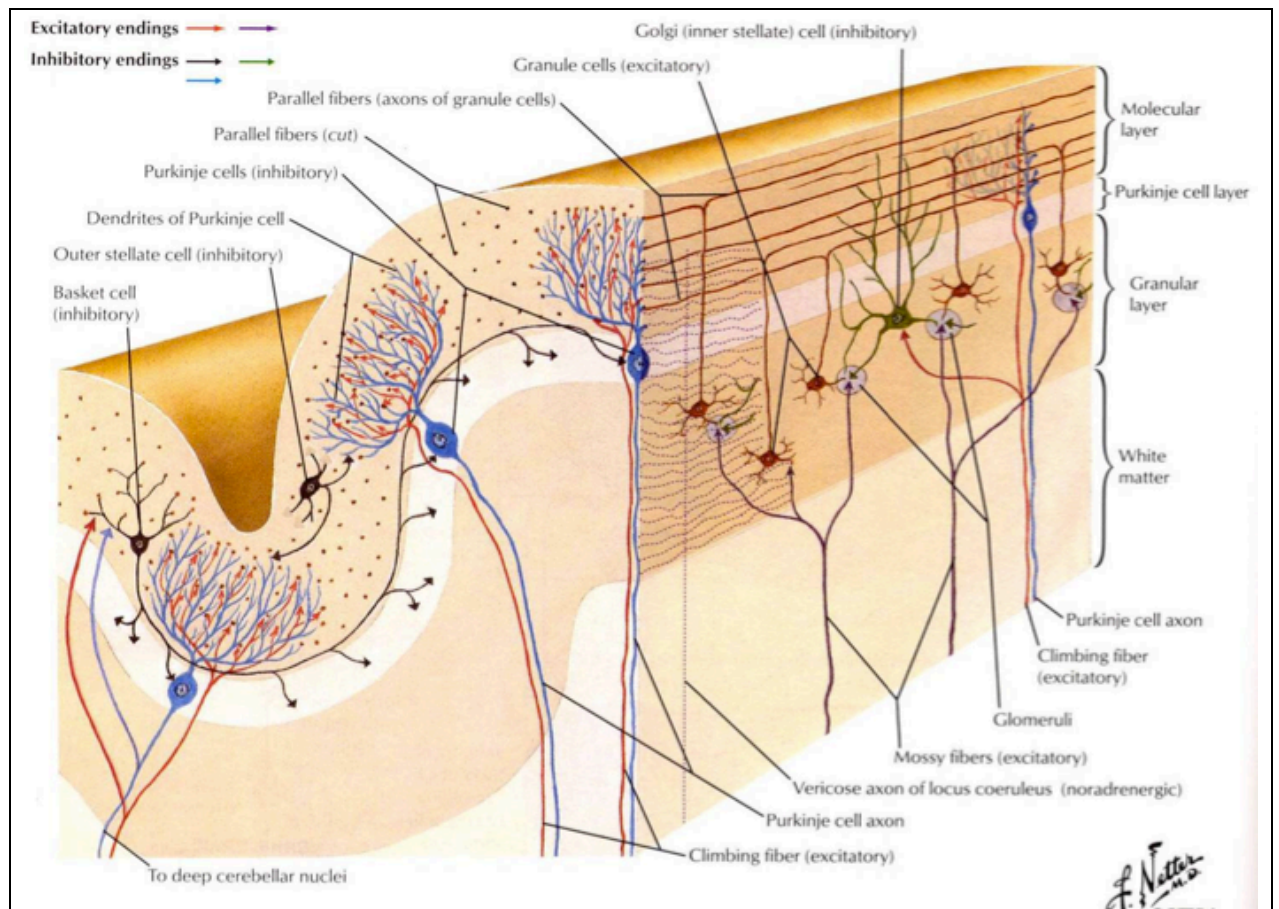
### Cortex

<i>Phylogenesis</i>			
Cerebellar Cortex	Parallel Development	Includes	Functions
<b>VESTIBULOCEREBELLUM</b> Archicerebellum	Vestibular organs		
<b>SPINOCEREBELLUM</b> Paleocerebellum	Vertebral spine		
<b>PONTOCEREBELLUM</b> Neocerebellum Cerebrocerebellum	Cerebral neocortex		

<i>Microscopic Properties: Cellular Layers of Cerebellar Folium</i>		
Cellular Layers	Layer	Contains
_____ LAYER	Outer	
_____ LAYER	Middle	One layer of Purkinje cells
_____ LAYER	Inner	



<i>Microscopic Properties: Cell Types</i>					
Cell Type	Cell Body Location	Dendrites/Axon Location	Afferents	Efferent	Transmitter
<b>PURKINJE</b>	Purkinje cell layer	Molecular layer	Proximal dendrites: <i>many</i> synapses from <i>single</i> climbing fiber	Distal dendrites: postsynaptic to about 200,000 parallel fibers  * <b>The only cell type able to give out efferent projecting fibers from cerebellar cortex</b>	GABA (inhibitory)
<b>GRANULE</b>					
<b>GOLGI</b>					
<b>STELLATE BASKET</b>					



<i>Microscopic Properties: Fiber Connections</i>				
Fibers	Excite / Inhibit Transmitters	Originate	Terminate	Description
<b>MOSSY</b>	Excitatory (Glutamate, AMPA, metabotropic rec)	Spinal cord Vestibular nerve Pontine nuclei	Cell bodies of granule cells (in granule layer, which are also excitatory)	>90% of all incoming fibers to cerebellum
<b>CLIMBING</b>				
<b>PARALLEL</b>				
<b>AMINERGIC</b>	Serotonin	Raphe nuclei	Almost all layers	Modulating influences
	Norepi	Locus ceruleus		

Nuclei (all paired)

<i>Nuclei</i>			
Nucleus	Associated Cerebellar Cortex	Function	
<b>FASTIGIAL</b>		Motor execution Modulate eye	Antigravity and postural maintenance in standing and walking (axial muscles) Modulation of saccade and smooth pursuit
	Spinocerebellum	Motor execution	Modulation of stretch reflex (distal muscles)
<b>DENTATE (Largest)</b>		Motor planning	Initiation and control (fine tuning) of volitional motor activities (programming and planning)
	Vestibulocerebellum (flocculonodule)	Balance Eye movement	Static and dynamic stabilization of gaze and posture

Connections

<i>Connections</i>			
Connection	INFERIOR CEREBELLAR PEDUNCLES (ICP)	MIDDLE CEREBELLAR PEDUNCLES (MCP)	SUPERIOR CEREBELLAR PEDUNCLES (SCP)
<b>Cerebellum to</b>	<b>Medulla</b>	<b>Pons</b>	<b>Midbrain</b>
<b>Incoming Fibers</b>	1. Primary vestibular afferents	1. Contralateral pontine	1. Ventral spinocerebellar tract
	2. Vestibulocerebellar projection		
	3. Olivocerebellar tract		
	4. Dorsal spinovestibular tracts		
	5. Brainstem reticular formation		
<b>Outgoing Fibers</b>	1. Cerebellobulbar tract	-----	All other cerebellar efferents  Two important feedback loops: cerebellum-cerebellum and cerebrum-cerebellum

<b>SCP Outgoing Feedback Loops</b>	
<b>Cerebellum-Cerebellum Loop</b>	<b>Cerebrum-Cerebellum Loop</b>
Triangle of <i>Guillian-Mollaret</i> : Cerebellar cortex → Dentate nucleus → (⊗,SCP) Red nucleus → ( <i>Central tegmental tract</i> ) → Inferior olive → (⊗) Cerebellum	Cerebrum → Pontine → (⊗) Cerebellum → Dentate nucleus → (⊗) Ventrolateral thalamus → Cerebrum
Cerebellar cortex → Dentate nucleus → (⊗, SCP) Red nucleus → (⊗, Forel) Spinal cord (rubrospinal)	

## 2. To understand the fundamental physiology of main cerebellar functions

<b>Pathways</b>			
<b>Cerebellar Path</b>	<b>VESTIBULOCEREBELLUM</b>	<b>SPINOCEREBELLUM</b>	<b>CORTICOPONTOCEREBELLUM</b>
<b>Territory</b>	Nodulus Bilateral flocculi	Vermis Intermediate hemispheres	Lateral cerebellar hemispheres
<b>Inputs</b>	1) Vestibular nerve and nucleus	1) Dorsal spinocerebellar tract 2) Ventral spinocerebellar tract 3) Cuneocerebellar tract 4) Others: auditory, visual, vestibular, cerebral	1) Corticopontocerebellar tract 2) Olivocerebellar tract
<b>Outputs</b>	Purkinje cells → 1) Bilateral vestibular nuclei 2) Contralateral cerebellum 3) Brainstem reticular formation	Purkinje cells (vermis) → fastigial nucleus → 1) Lateral vestibular nucleus 2) Contralateral ventrolateral thalamus 3) Brainstem reticular formation  Purkinje cells (paravermian hemisphere) → interposed nuclei → 1) Contralateral red nucleus 2) Contralateral ventrolateral thalamus	1) Dentatorubrothalamic tract
<b>Functions</b>	Maintenance of equilibrium Static and dynamic gaze stabilization Static and dynamic posture control	Controls muscle (axial and proximal) tone, synergy, and stretch reflexes to ensure execution of movement	Receives cerebral planning about voluntary movement in advance Compares planning and actual motion Modulates pyramidal and extrapyramidal actions to ensure precision and smoothness of complex motion
<b>Lesions</b>	Distorted equilibrium (astasia, abasia, ataxia, nystagmus, tendency of falling)	Ipsilateral truncal and limb ataxia Gait disturbance Scanning speech	Distal ataxia, Dysmetria, Asynergia, Dysdiadochokinesia, Intention tremor, Hypotonia Delay in initiation of motor task Inability to estimate weight

## 3. To understand the clinical presentations of cerebellar disorders

<b>Pathway</b>	<b>Function</b>	<b>Signs and Symptoms</b>
<b>VESTIBULOCEREBELLUM</b>		
	• Axial and proximal muscle synergy	• Ataxia • Gait disturbance • Asynergia • Scanning speech
	• Axial and proximal muscle tone • Stretch reflexes	• Hypotonia • Altered tendon reflex
<b>CEREBROCEREBELLUM</b>		

#### 4. To develop general knowledge of the main categories of cerebellar diseases

\*\*\*NOTE: I made this table so I could see all the cerebellar diseases at the same time. DO NOT MEMORIZE EVERYTHING. Just note the CATEGORIES of the diseases and have an idea of *some of the examples* and what sorts of problems may arise.

<i>Category of Cerebellar Disease</i>	<i>Examples</i>	<i>Other Descriptions</i>
<b>CONGENITAL MALFORMATIONS</b>	1) <i>Arnold-Chiari</i>	Cerebellar herniation, medulla distorted, syrinx formation
	2) <i>Dandy-Walker</i>	Absence of vermis
	3) <i>Aplasia, hypoplasia, dysplasia</i>	Agenesis, not differentiated properly
<b>IDIOPATHIC AND HEREDITARY</b>	1) <i>Familiar ataxias</i>	Friedrich's
	2) <i>Intention tremor</i>	-----
	3) <i>Palatine myoclonus</i>	Persists – M.S.
	4) <i>Multiple system atrophy</i>	-----
<b>TRAUMA AND VASCULAR LESIONS</b>	1) <i>Trauma</i>	Skull fracture, brain concussion, contusion
	2) <i>Vascular Lesions</i>	TIA, ischemic and hemorrhagic strokes, vascular compression, arterial dissection <ul style="list-style-type: none"> <li>- Wallenberg</li> <li>- Inner ear</li> <li>- Upper basilar</li> </ul>
	3) <i>Complications</i>	Hydrocephalus, mass effect, herniations (uncus and tonsils)
<b>TUMORS</b>	1) <i>Primary Cerebellar Tumors</i>	Medullablastoma, pilocytic astrocytoma, hemangioblastoma, ependymoma, etc.
	2) <i>Paraneoplastic syndromes</i>	Cerebellar degeneration, opsoclonus
	3) <i>Metastasis</i>	-----
	4) <i>Tumors from surrounding tissues and structures</i>	Meningioma, acoustic neuroma
<b>INFECTION</b>	1) <i>Viral</i>	Varicella, coxsackie, echovirus, EBV, HIV, West Nile
	2) <i>Lyme disease</i>	Borrelia burgdorferi
	3) <i>Postinfections (pan)cerebellitis</i>	Flu
	4) <i>Bacterial</i>	Whipple's disease
	5) <i>Fungal and parasitic</i>	Plasmodium falciparum, mycoplasma, cysticercosis, toxoplasmosis
	6) <i>Prion</i>	-----
<b>PAROXYSMALS</b>	1) <i>Migraine</i>	-----
	2) <i>Mal de débarquement syndrome</i>	-----
	3) <i>Motion sickness</i>	-----
<b>NEUROTOXICITY AND ADVERSE EFFECTS OF MEDICATION</b>	1) <i>Drug</i>	Phenytoin, carbamazepine, lacosamide
	2) <i>Alcohol-related cerebellar degeneration</i>	-----
	3) <i>Chemotherapy</i>	5-fluorouracil, cytosine, arabinoside, piperazine
	4) <i>Metals</i>	Organic mercury, thallium, bismuth
<b>METABOLIC, ENDOCRINE, NUTRITIONAL DISORDERS</b>	<i>Thiamine deficiency, vitamin E deficiency, hypothyroidism</i>	
<b>INFLAMMATORY AND AUTOIMMUNE DISORDERS</b>	1) <i>Inflammatory vasculopathy</i>	SLE, rheumatoid, Wegener's granulomatosis, Behcet's disease, Cogan's syndrome, Susac's syndrome
	2) <i>Autoimmune</i>	-----
	3) <i>Demyelination</i>	M.S., disseminated encephalomyelitis
<b>NON-NEUROLOGICAL CAUSES</b>	1) <i>Psychiatric</i>	Conversion disorder, somatoaffective disorder, factitious disorder, phobia
	2) <i>Others</i>	Malingering